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The role of the parataxonomists, curators and international taxonomists in Costa Rica's National Biodiversity Inventory.

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Here we briefly describe the parataxonomists by the device of describing their training program, and what has been their role in the preparation for the national biodiversity inventory (to begin in 1993). This is followed by a brief discussion of the INBio curators, and the INBio interaction with the international taxononomic community.

THE PARATAXONOMISTS

Introduction

INBio has accepted the responsibility of undertaking a national inventory of Costa Rica's biodiversity in a ten-year period beginning in approximately 1993. This is being done in strong collaboration with the Ministry of Natural Resources, Energy and Mines (MIRENEM) in general and the Conservation Area administrations specifically, with growing involvement by Costa Rica's two major universities. The intent of this inventory is to render the species and information in Costa Rica's biodiverse wildlands accessible and usable by society for intellectual and commercial purposes. Costa Rica's conserved wildlands thus have the chance to become directly productive and a significant contribution to both their own costs of upkeep and to GNP. Conservation per se thus becomes a highly desired by-product rather than the only goal.

Ten years was chosen as being long enough to do the inventory but short enough to allow the results to become available quick enough to have an impact. If Costa Rica does not have its Conservation Areas - as mentioned elsewhere, about 25% of the national territory as wildlands conserved for their biodiversity - recognized as a firmly productive sector within 1-2 decades, these wildlands have little or no chance of withstanding the environmental onslaught from the pending major increase of the population during over the next ten years, the pending national social reorganizations, the pending environmental contamination/changes from industrialization and thorough agriculturization, and the acquisitional drive of clever individuals. If Costa Rica's biodiversity is to survive, it must be made usable for both intellectual and economic gain of sufficient magnitude that Costa Rica's society will aggressively conserve it into perpetuity.

INBio's philosophy is to increase the inventory expenditure and workforce to a level whereby the task can be conducted within ten years, rather than to expect that conventional rates and protocols can do the task in ten years (which they could not).

The explicit task of Costa Rica's biodiversity inventory is to insure a relatively stable system of Latin binomial (and higher) nomenclature for the organisms, begin to know the location of this biodiversity within the country and within the greater body of scientific knowledge, and begin to accumulate natural history information about the species and their interactions. With this framework beginning to take shape, all of the ecological, chemical, behavioral, genetic, etc. information to be gathered about Costa Rica's biodiversity can be organized, related, manipulated, and offered to the country, region and world through the public domain and through sale to commercial sectors. And rational decisions can be made about what more of it to save at what cost. Costa Rica's "new" national biodiversity inventory formally begins at the time that INBio receives a major block of funding for the inventory activities. At present, INBio is in the process of planning this inventory by conducting various parts of it, in effect as small scale "trial runs" and "pilot projects", a kind of institutional "on-the-job training".

The parataxonomist program is one such pilot project. Unexpectedly, the parataxonomist program has caught the attention of a tropical international community that is confronted with wildland biodiversity management and use problems similar to those in Costa Rica. As such, the parataxonomist program has also become an unintentional pilot project for other countries as well as for INBio and Costa Rica.

Parts of Costa Rica's biodiversity inventory has been unofficially and irregularly in progress for more than a century by a wide variety of national and international biologists - largely but not exclusively taxonomists - working inside and outside of Costa Rica. In almost all cases, these efforts have been guided by the specific taxon-based interests of an individual or an institution, and to support the centuries-old traditions of academic/taxonomic science, rather than focused directly on facilitating the management and use of Costa Rica's biodiversity by society. However, the results from these initial efforts form the irreplaceable and essential base from which the national inventory begins, and are in large part responsible for the existence of a contemporary Costa Rican human resource and knowledge base from which to build the staff and abilities for a national biodiversity inventory.

A major component of INBio's ten-year inventory is the actual collection and preparation of the specimens (and associated information) in the field and getting them to INBio for subsequent processing by taxonomists, biodiversity information managers, and other users. This collection and preparation is carried out by a team of Costa Rican biologists termed "parataxonomists" who conform the "Parataxonomist Program" within the National Biodiversity Inventory at INBio. Jorge Jimenez, formerly a professor of ecology at the National University, is the Director of the National Biodiversity Inventory.

Background

Costa Rica does not have the luxury of being able to use many decades and many millions of dollars to train a large number of Ph.D.s and university-graduate technicians to eventually inventory its biodiversity. Equally, it can not expect the international science community to abandon all of its other activities and come to Costa Rica and conduct her inventory. And certainly, the inventory of Costa Rica's biodiversity cannot wait the several centuries that either option would demand.

INBio has taken the route of planning to use Costa Rica's two abundant underutilized resources - the rural populace and wildland biodiversity - in collaboration with the international taxonomic community, to achieve a biodiversity inventory in a decade at a reasonable cash cost. The rural areas of Costa Rica are rich in highly capable adults who are, quite frankly, working at jobs far below their intellectual and energy levels. Additionally, the international scientific community, largely but not entirely of the developed world, has long overestimated the amount of training that is required for an individual to become a major participant in a task as complex as a thorough inventory of the species in a complex tropical wildland. Second, if properly offered, Costa Rica's biodiversity itself can be a powerful magnet for short term international technical and training assistance to gear up the Costa Rican human resource to where it can do the job itself.

A chronological history of the parataxonomists

A detailed examination of the historical roots of the parataxonomists is important in helping to understand some of the important ways that they differ from "collectors" and "biological technicians", with which they are frequently confused. This distinction is in turn important because it underlines some of the subtilities that have proven to be very important in successful parataxonomists.

From 1974-1979 Gerardo Vega was hired as a field assistant by Janzen to help with NSF-supported ecological field experiments and insect collecting in Corcovado National Park and Santa Rosa National Park. Vega had been a Costa Rican farmer, hunter, drunk, gold miner, squatter, liquor-smuggler, national park helper, etc. He was smart, tough and very interested in the work, and had three years of formal education. His national park employers were eager to be rid of him because he always felt he knew how to do things better than his administrative superiors. His parents had been coffee pickers. From 1983 to 1989 Roberto Espinoza was hired for the same job, after Vega returned to gold mining. And Espinoza was also smart, tough and very interested in the work. Espinoza was from the small fishing town of Cuajiniquil in northern Guanacaste Province, on the north boundary of the Guanacaste Conservation Area. He had six years of formal education, and had been a machete swinger, cowboy, and fishing boat helper. His parents were ranch employees, cowboy and housewife. Both Vega and Espinoza were chosen for extensive experience and capacity in the field, for being extremely curious, for being extremely tough physically, and for getting intensely involved with whatever they were doing.

It quickly became evident that Vega and Espinoza had the ability to be doing yet much more - especially with respect to accepting responsibility and learning complex tasks. Furthermore, they offered more assistance and enthusiastic involvement in field work than is generally observed from Costa Rican university students (volunteer and employee), and more field competence than is usual with all but the most exceptional of the enthusiastic US graduate students visiting and working in field biology in Costa Rica during the past several decades.

Simultaneously, the NSF-supported "Moths of Costa Rica" project began in 1978, initially to get stable names on the adults of caterpillars being reared in herbivory studies in the dry forest of the Guanacaste Conservation Area. This project employed Isidro Chacon and Maria Marta Chavarría - both quite exceptional students from the University of Costa Rica - to live in a single site (SPN Estacion Carrillo and the OTS La Selva

Biological Station, respectively) for a year and do nothing but collect and spread moths. And Isidro taught his brother Abelardo Chacon to do the same. The quality of their work as unsupervised collectors was excellent, even under very trying field and administrative circumstances.

As the idea of the donor-supported "Guanacaste National Park Project", the recent ancestor of the Guanacaste Conservation Area, took root in February 1986, it became evident that an insect inventory of this 100,000 ha area of dry forest, cloud forest, rain forest, and intergrades would be of great value in understanding insect migrations, seasonality, micro-distributions and other ecological parameters that could affect direct management decisions. Such an inventory was visualized as building on the NSF-supported informal arthropod and plant inventory of the GCA region that had been initiated about 1968.

Therefore, in 1986-1988, local rural adults from the boundary zone of the GCA were hired and trained to help in the inventory collecting. The emphasis was on producing people able to collect and prepare insects with minimal supervision. They taught each other and visiting foreign researchers taught them as well. Several Costa Rican biologists also helped, especially Angel Solis (today, the Arthropod Department chairman at INBio). Most of these people - Roberto Espinoza, Elda Araya, Calixto Moraga, Petrona Ríos - are among today's parataxonomists because they were obvious candidates for the first parataxonomist course in 1989. Espinoza is now the GCA Resident Botanist. As of late 1992, along with Roger Blanco, Elba Guadamuz, Carolina Cano and Dunia Garcia, who joined after graduation from parataxonomists courses, they constituted the Biodiversity Inventory subprogram of the Research Program of the GCA.

The first parataxonomist course, January-July 1989.

However, in the fall of 1988 the GCA was suffering the anguish of attempted integration with the remainder of the Costa Rican National Park System. There was a very clear need for staff from other Costa Rican national parks to observe and understand the micro-revolution in administrative structure and philosophical attitudes that characterized the GCA. Simultaneously, US-AID made known that it would be supportive of any GCA educational effort that dealt with the environment, Costa Ricans and the other parks. The solution was to formalize the efforts to train people for the GCA inventory into a six month full-time course (January-July 1989) and include ten additional persons from the Costa Rican national park system. Since there were already five collectors beginning to work in the GCA, only one park service employee from the GCA was admitted, and the other ten park service employees were distributed among the national parks Corcovado, Amistad, Carara, Tortuguero, and Braulio Carrillo. Today, these national parks are core parts of the Costa Rican Conservation Areas.

A six month full time course was deemed necessary because of the lessons learned with the subject matter during the process of producing high quality field research assistants and insect collectors in previous years.

The basic agreement was that the US-AID $120,000 course would provide the training, supplies, equipment, and supervision (field liason and coordination from INBio) for a year of work (including the six months of the basic course), and the graduates' employers would provide their salaries and office/living space for ongoing work (during the course as well as after).

There was no formal contract as to this employer/training relationship, but rather there were various explicit and implicit agreements at the level of the directorate of the National Park Service, MIRENEM, and the directors of the individual national parks. Eleven of the first parataxonomists were therefore government employees and five were NGO employees of the Guanacaste Conservation Area (then the Guanacaste National Park Project) under the fiscal administration of the Fundacion de Parques Nacionales (a semi-government NGO). These institutions thus donated a given type of employee (rural collector, park ranger) and received a parataxonomist in return. It was understood by all concerned that the idea was to generate a new kind of vocation, populated by people who would take this on as a life-time occupation.

The students were taught "What it is that a non-biologist rural adult really needs to conduct a serious inventory, get started and continue through on-the-job training, working essentially by oneself with no supervision in the field and only occasional feedback from INBio when specimens are brought in". In essence the course contains many aspects of those "old-fashioned" university courses (ornithology, herpetology, entomology, cryptogamic botany, field botany, algology, etc.) that are pertinent to conducting an inventory - collecting and preparation techniques, basic natural history, basic taxonomy, basic evolution and ecology, conservation rationale, etc. The course became these things plus innumerable footnotes and detours to pick up some basic details of genetics, math, natural products chemistry, physiology, anatomy, etc. These things were mixed with theory and practice of how to drive a car and chain saw, care and use of horses, how to use a computer and a topographic map, how to use a field guide in a foreign language, how to manage a budget and petty cash fund, how to interpret and tolerate foreigners, what is administration and why, structure and content of environmental legislation and conservation propaganda, funding for research, personal relationships with government and NGO administrators, how to feel self-confident in the face of depreciatory assault, how to teach, etc. Associated with being able to do the above things are more personal things, such as getting one's first pair of eye-glasses and learning how to use them, learning how to work alone at night in the forest without fear, losing excess weight, learning how to receive and absorb criticism, etc.

There was a major question of what persons would be best for this new vocation. A notice briefly describing the course and the parataxonomist's vocation/responsibilities was circulated by the course coordinator (Isidro Chacon) among the headquarters of the Costa Rican national parks in late 1988. It had a form asking for standard biographical information (education, present job, etc.) and a request for the applicant to write a short essay about why he or she wanted to become a parataxonomist. In this first course, only personnel of the GCA (legally, employees of the Fundacion de Parques Nacionales) and the National Park Service could apply. From the 28 completed application forms that arrived, 22 of the best were selected for interview based on the content of the form, with some bias introduced by the reputation of the individuals within the National Park Service. The interviewees were invited to come to the GCA by bus for individual interviews with the course faculty, the course coordinator, and at least one member of the GCA Administration. Eleven new people and the five GCA insect collectors were selected for the course after the interviews, and after gaining final approval for the selection by the employee's administrators. Employer approval of candidate selection

was essential, since the employer was experiencing the exchange of one kind of staff member for a parataxonomist, a new and unknown kind of staff member.

The final candidates were chosen almost entirely based on the subjective evaluation of all involved, for enthusiasm for the challenge, basic intelligence, frustration with the status quo of their current jobs, independence (or reputation for it), and liklihood of being robust in a purely field circumstance. In the years since the selection of the candidates for both the 1989 and 1991 courses, it has been discovered that many of the successful candidates were previously viewed by their employers as “problem persons”, famous for not fitting very well into their unchallenging civil service work regime as National Park personnel.

While two women were present in the first parataxonomist course and have since proved to be outstanding parataxonomists, they were among the five collectors contributed by the GCA. No other women applied for either of the first two parataxonomist courses. The third parataxonomist course, in 1992, had 18 women and 3 men, as a way of redressing this imbalance. This was achieved by having the salary lines so as to be able to seek candidates from the populace at large.

The term "parataxonomist" was borrowed from "paramedic". It has been clear from the beginning that the goal in the training program was to prepare a person for an highly independent vocation, rather than to lay the first steps for progression to advanced degrees and university-level employment. However, a few parataxonomists have and will undoubtedly go on to more complex training due to the impulse that has been given to them by starting out as parataxonomists. The parataxonomists are not called "barefoot taxonomists" both because they are not barefoot and because of the lack of respect that is implied by that term. The parataxonomists are not called "technicians" (though Costa Rican society, and especially civil service evaluations, have a strong tendency to do so) because the stress is on ability to work independently and to understand the philosophy behind what they are doing (neither of which are characteristic of technicians in this society).

The Costa Rican course coordinator and teaching assistant, Isidro Chacón, was at that time on leave from the Museo Nacional and served in this capacity until graduation, at which time Maria Marta Chavarría assumed responsibility for the parataxonomist program. She has continued ever since as coordinator for the parataxonomists (and their administrations), and field liason with the INBio central facility.

This kind of course only works with total immersion by all involved. Formal lectures, discussions, lab work and field activities were opportunistically intermingled and continuous from 7 am to 6 pm (one hour for lunch) for 10-15 day periods, followed by 3-4 day breaks during which students left the ACG to visit families and attend to other obligations. Many nights were also spent in the field in actual collecting activities.

Much of the content of the course was guided by preparing the parataxonomists for questions such as the following, both with respect to being able to begin to answer them and how to continue developing understanding of them:

1. How can one use an identified reference collection of the species of moths, beetles, wasps, butterflies, etc. occurring in a conservation area? How does one use other kinds of biodiversity information (e.g., numbers and kinds of habitats and climates, numbers and kinds of plants, locations of populations)? How does biodiversity

information help in the conservation, management and development of a conservation area?

2. How does one know when enough collecting of a group has been done so as to stop and work on a different group? How many specimens of a "species" should be collected from the taxonomist's viewpoint and from the viewpoint of the conservation area?

3. How can one know if a sample of species is representative of what species are actually there? How does one decide in which habitats to collect?

4. What can one do to encourage professional taxonomists and other kinds of biologists to work on the specimens you are collecting rather than those from other places?

5. How does one justify the production of local field guides (fast) for conservation areas when the taxonomists like to do revisions (slow) of all the species in large geographic areas? What are the steps to producing a field guide, and what material is needed? What does the public want from a field identification manual?

6. How can one determine if a particular kind of collecting will damage the biology of a conservation area? How does one integrate collecting and other biodiversity survey activities with other kinds of research and management in a conservation area?

7. How are scientific names produced, why do we have them, how can they be used to locate other scientific information? What is a research collection and what is a national museum? What is a species? What is a population?

8. What are the basic natural histories of the different groups of animals and plants that are encountered and how does this relate to a biodiversity survey?

9. How can the gathering of biodiversity information best be coordinated with a conservation area's management needs?

10. Why should specimens be viewed and treated as international property, and distributed broadly among responsible users? How does one integrate actual collecting activities with the activities of other users, including other collectors?

11. What are the collector's responsibilities to the questions from the observant public? Should there be specimen displays in a conservation area? Who should take care of them? How should they be taken care of?

12. Why are conservation area critical for the maintenance of biodiversity?

13. Why do we want to conserve and maintain a very large portion of the diversity of the earth's organisms and habitats?

14. Why should Costa Rica be particularly concerned about the conservation of its biodiversity, and how does this relate to the biodiversity of the remainder of the world?

After two months of this very intense activity, the students were sent back to their “home” conservation areas to work independently for a month, practicing what they had learned. They then returned to the GCA for two more months of intense training like that in the first part of the course.

International taxonomists and Costa Rican university and museum personnel were opportunistically invited to visit and talk about their specialty, and how to collect their specialty taxa.

The buildings, vehicles, and field stations of the Guancaste Conservation Area provided the logistic support for the course (the GCA was actually decreed at the end of the course, as the Guanacaste Regional Conservation Unit). The staff of the GCA

provided diverse administrative and moral support to the course, a course that was viewed by all as a giant experiment in Costa Rican conservation sociology.

Insects and higher plants received the heaviest emphasis as teaching tools during the course because a) they are where the most intense need is at present in Costa Rican biodiversity inventory (both with respect to numbers of species and potential novel uses), and b) they offer a huge number of easily accessible examples of evolution, ecology, development, mimicry, protective chemistry, complex life cycles, etc. Additionally, the inventory of Costa Rican vertebrates is essentially done (except for some special work yet in small reptiles and amphibians), and inventory of micro-organisms, fungi, diatoms, etc. will be best conducted by parataxonomists with training in addition to the basic training described here.

Upon graduation, it was intended that the parataxonomists would return to their source conservation areas, establish Biodiversity Offices, and go to work. They did.

Training in scientific and practical matters has continued on a less formal basis since the end of the course, particularly through the field liaison, the INBio curators and staff, and some visiting scientists. There have also been formal short courses specializing on particular groups of organisms, taught by Costa Rican and international systematists who in many cases are world authorities on their taxa (see questions below).

As soon as the first course was in progress in early 1989, the students (the first group of parataxonomists) began to generate very large amounts of high-quality mounted specimens. There were far more specimens than the facilities of the Museo Nacional could even imagine storing or processing. At about the same time (February-March 1989) the idea of an INBio was born through the convergence of many similar conservation-related currents and actions in Costa Rica, a convergence that began in MIRENEM about October 1988. This idea was realized in the form of the first INBio building in Santo Domingo in May of 1989, just in time to offer shelter and custody to the collections and curators of the Department of Natural History of the Museo Nacional. The latter department had just been evicted by the remodeling of the western face of the Museo Nacional building. With no place to go (and the huge volume of work being done by the Missouri Botanical Garden "Manual of the Flora of Costa Rica" project), they quite literally moved from the bulldozer blade to the still wet floor of the new INBio building. This building also opened just in time to receive the first large bulk deliveries of insects and plants from the first parataxonomists course.

In summary, the first parataxonomist course was generated by
- need for the beginning of an inventory of the Guanacaste Conservation Area,
- expression of interest by US-AID in supporting something similar on a national level,
- willingness (not described here) of the US National Science Foundation to informally and

opportunistically support inventory development in the nascent INBio,
- awareness that parataxonomists could be drawn from rural Costa Rica, and
- willingness of the administrations (and government) of Costa Rica's conserved wildlands to provide salary lines

for this activity.

To the course faculty, it appeared as an interesting teaching challenge and something that satisfied the feeling that at this stage in history, academics cannot afford the luxury of continuing with business as usual. Also the faculty found it to be enormously

stimulating, since the students reminded one of the enthusiasm and moral idealism of the university body of the late 1960's and 1970's in the USA.

The second parataxonomist course, May through August 1990.

In May-August 1990, a second and quite similar parataxonomist course was taught, financed again by US-AID, but this time via the Biodiversity Support Program, administrated by a consortium of WWF-US, TNC, and WRI. The Course Coordinator and Teaching Assistant this time was Manuel Zumbado, a parataxonomist graduated from the first course. As with the first course, the entire course was taught in the GCA, making use of its field stations located in almost all of the kinds of habitats that are represented in Costa Rica's conservation areas. However, it was now clear that the parataxonomists have an institutional home at INBio, no matter that they work all over the country and are paid by a variety of employers.

As in the first course, the general structure was intense 7-10-day periods of study and field work at this or that GCA field station, interspersed with 2-4 day vacation periods to visit family and travel. After two months of this, each parataxonomist returned to his "home" park and worked for a month on his own. The parataxonomists of the first course set up the first Biodiversity Offices in the conservation areas during this mid-course trial, and the parataxonomists of the second course used the established Biodiversity Offices while their occupants were off taking an advanced parataxonomist course in the GCA and in INBio, in Microlepidoptera in mid-1990. The students of the second course then returned to the GCA for another period of a month of intensive study. At the end of the second course, all parataxonomists from both courses conducted a 3-day field workshop in marine invertebrates on the Islas Murciélagos in the western end of the GCA.

In the second course, the student source pool was broadened to also include employees of the National Forest Service and two conservation-oriented NGOs. A private lumbering company was also invited to support a parataxonomist, but voided its contract after three months when it discovered that the parataxonomist would answer to INBio, rather than to the company. The parataxonomist, however, was incorporated into the budget of the nearby Tortuguero Conservation Area.

In retrospect, there were three major errors made with the second course. First, it was two months shorter than the first (4 months versus 6 months). This two month delay - and attempted compression of many of the teaching activities - occurred because of administrative disagreements about the availability of the government-employed students that were selected for the course, and chaos in Costa Rica's conservation efforts as fallout from the change in political parties following the early 1990 presidential election. Second, the course relied too heavily on the outstanding course coordinator for too much of the teaching. A second-year parataxonomist, no matter how good, does not have the pedogogical stamina and a strong enough grasp of the basic material be able to carry a major teaching role. Third, other persons were allowed to select three of the participants. All three of these participants failed as parataxonomists following graduation, and are no longer with the program. It is extremely difficult for non-INBio personnel to choose good candidates because they are not truly aware of what characteristics are of greatest importance, and what is expected of the graduates.

The third parataxonomist course, January-June 1992.

No course was offered in 1991 for three reasons. First, it was necessary to raise sufficient funds for a third course. A pledged donor withdrew support, and three years

are required for the INBio-Pew Teaching Endowment to generate enough interest income to cover a major part of the cost of a course. Second, it was decided to allow time for the first parataxonomists to function, and then use feedback from that function to determine how the course should be modified. Third, it was useful to allow a respite for the faculty from the stress of teaching a parataxonomist course. Also, an intensive NSF-supported two-month advanced course in Hymenoptera was taught to the parataxonomists during the first half of 1991.

In late 1991 INBio received a grant from the Liz Claiborne and Art Ortenberg Foundation for three years of salary and operations costs for 10 female parataxonomists. The ensuing 1992 course is supported by the National Fish and Wildlife Foundation, the Moriah Fund, the Conservation, Food and Health Foundation, SIDA of the Swedish government, and INBio's Pew Teaching Endowment. It contains 18 women and 3 men and has been highly successful. What it has produced will be the subject of a different report, and requires further detailed analysis. Suffice to say that the serious male sex bias among the parataxonomists has been substantially corrected, and a parataxonomist course constituted largely of women involves a whole new set of challenges and opportunities.

Questions commonly asked about the parataxonomists.

One of the characteristics of total immersion in the reality of conservation development in a tropical country is that it does not leave time for academic analysis of all processes deserving of such analysis. This is not the place to present a fully considered synthetic analysis of the parataxonomists and their courses to date. Instead, for the purposes of introduction to the topic, we briefly reply to some of the most commonly asked questions about the parataxonomists and their program.

1. What are the goals of the parataxonomists?

A parataxonomist's present-day goal is to initiate and conduct an inventory of the fauna and flora in the vicinity of his or her respective Biodiversity Office, emphasizing those taxa that the curators and other the guidance processes at INBio indicate are appropriate at that time. This group-specific emphasis is an essential ingredient both because certain taxonomic groups require little or no further national-level inventory (e.g., birds, mammals, large snakes, macrobutterflies, sphingid and saturniid moths, many groups of macromoths), because the parataxonomists have not yet received specialized training for collection or observation of certain taxa (e.g., diatoms, mites, algae/lichens, fungi, mosses), or because INBio does not yet have the facilities to handle the specimens (e.g., small reptiles and amphibians, spiders, marine invertebrates, microbes, living cultures).

The site-specific emphasis is necessary so as to insure sampling at all times of year and to insure collection of those species that can be collected only in certain years. Superficial "collecting trips to the field" have been the basis of most tropical inventory activity for more than a century, and the year-round presence and intensive re-working of an area is intended to avoid this problem. Site-specific emphasis is also very important for the parataxonomist to gain species-level familiarity with a given fauna and flora so as to avoid wasting time on excessive collecting of the same species and, on the other hand, so as to be able to do repeated collection on later dates if so directed by INBio.

Finally, through frequent contact with many species at different times in the year and in different circumstances, the parataxonomist learns first-hand a substantial amount of natural history and behavior. This information is now beginning to be tapped by

INBio and other biodiversity managers for biodiversity prospecting, conservation management, ecotourism, education programs, etc. This ecological and natural understanding by the parataxonomist is also critical to maintaining a high personal interest and involvement by the parataxonomist in the work itself. Simple collecting of unknown and non-understood specimens quickly becomes a boring task, one that does not lend itself to independent work in the isolation of a field station. Finally, this understanding is critical to further employment and intellectual involvement by the parataxonomist once the inventory is completed and more human resources are needed in the "use" phase of biodiversity conservation.

Long term residence in an area is also essential to knowing, developing and managing all of the logistic and social threads that characterize 1) successful survival of the parataxonomist in the administration and microsociety of the Conservation Area, and 2) strong flow of his or her influence and knowledge into the surrounding general community. The latter is inextricably intertwined with the fact that more and more of the parataxonomists have families at the site and will spend major portions of their lives in the area.

The last two decades of intensive collecting at particular Costa Rican sites by individual taxonomists or ecologists working on a specific major taxon has often shown that almost all of a major habitat's fauna can eventually be found at one site, if the site is studied year round and for several years. For example, a single light placed in the right place in Santa Rosa National Park in the Guanacaste Conservation Area will get at least 99% of the entire macro-moth fauna of this 10,500 ha park in about five years. Such a survey can be conducted even faster with multiple lights, and by moving lights around within the park. Fifteen sites of about 10,000 ha each in Costa Rica's conservation areas could be chosen so as to yield 90% of the country's fauna and flora in ten years of collecting. As a site becomes well-inventoried, the parataxonomist will (and does) range further afield to locate concentrations of species not yet collected, both because this is more efficient than is waiting for the species to eventually be encountered at one small site, and in order to maintain personal interest in the task.

The feedback from INBio as to which groups to collect varies among the conservation areas according to

- the perceived need of particular conservation areas,
- variation among individual parataxonomists in their personal circumstances and abilities,
- what kinds of emphases are being placed on what taxa by what specialists (taxonomists or other kinds of users collaborating with INBio),
- the species richness of the area, and
- the number of person-years that have been invested in a particular Biodiversity Office.

For example, when a new Biodiversity Office is first established in a conservation area, the first year is spent on intense general collecting of all groups of insects and plants.

There is a second, more subjective and more global goal of a parataxonomist. Attaining this goal is often viewed as a byproduct by the working scientist, but is a primary goal of the parataxonomists program when viewed in the context of the larger goal of conserving Costa Rica's biodiversity. The parataxonomists have substantial contact with their associates in the park service, with family members, and with the neighborhood. The latter includes Costa Rican apprentices, school groups, tourists,

ecotourists, businessmen, neighbors and associates on the street. To all these people, the parataxonomist legitimizes the study and understanding of wildland biology, and directly and indirectly promotes biological literacy in a multitude of ways. This promotion is done at a level of language and socialization at the very core of the rural populace that have long been the direct attackers in the age-old human war against wild tropical nature.

The current parataxonomist has a third goal of extreme contemporary importance to INBio. This goal is to illustrate the problems and strengths of this way of approaching a national inventory of a very large and complex biodiversity. When the ten-year national inventory officially gets under way in 1993, it is anticipated that the parataxonomist staff will grow to one hundred or more working throughout the country, with frequent replacements and upgrading being a continuous process. Many of fully-operative parataxonomists from the first two courses (and the current 1992 course) will likely be examples, teachers, coordinators and facilitators of the actions of this entire team. Today's parataxonomists are a giant experiment in training, institution building, and goal-directed science. The methods of teaching and guiding these 100+ (mostly new) parataxonomists will be shaped by our experiences from 1989-1992. This is what INBio means by "planning by doing". The science public has already come to view the millions of specimens accumulated to date by the parataxonomists as a marvelous product, but in fact INBio and Costa Rica are still in the planning stages.

2. What is the goal of the inventory?

The goal of the inventory is to

1) get Costa Rica's biodiversity as nomenclatorially stable as is reasonably possible, and

2) have a first approximation of where it is (in the sense of being able to relocate it for use, and begin to know what is necessary to be able to use it witout destroying it).

The first goal is necessary so that

i) biodiversity information can be organized and managed at the level of species,

ii) the very powerful inferential tools offered by taxonomy can be used in biodiversity prospecting and management inference, and

iii) Costa Rica (INBio) can gain access to the vast amount of information that already exists in the international scientific literature about Costa Rican biodiversity, information derived from studies that have been conducted both inside and outside of Costa Rica. It is, for example, little appreciated that easily 60% of Costa Rica's half million species range over 10-20 degrees of latitude and many of them have been studied, albeit sketchily, in other regions (this applies, incidentally, to a very large number of tropical species, no matter what country is viewed as their "home" country).

The non-scientist, who has generally never suffered the consequences of attempting to manage a large and complex body of information without having a stable nomenclature for the basic parts, does not intuitively attribute this first goal to a national

inventory. However, in fact it must either predate or go hand in hand with the efforts toward the second goal.

The second goal is necessary so that genes, tissues, seeds, adults, products, etc. can be offered to user processes - whether these be the production of field guides for ecotourists (school groups, OTS courses, holiday visitors, etc.), computerized "literature" for grade schools, genes for biotechnologists, chemicals for the pharmaceutical industry, seeds for reforesters and agriculture, or whatever. A reinforcer of this second goal is that as the sources for specific things of value become associated with specific conserved wildlands, there is a quite human Costa Rican response to want to save a specific wildland because of that association. This reinforcement is underlined by actual income flow into Costa Rica for biodiversity goods and services, and some day it will even be part of the magnet for the movement of industries that use biodiversity materials to Costa Rica.

The goal of INBio's biodiversity inventory, and therefore that of the Costa Rican parataxonomists, is explicitly not to make decisions about what major areas of wildlands to conserve in Costa Rica. On the large scale, Costa Rica's system of conserved wildlands is already established for nearly all intents and purposes. When further fine-tuning is required or desired, there are usually far more rapid and effective ways to arrive at a general decision as to whether to conserve pieces of habitat, than by conducting detailed and time-consuming inventories to add to what is already known through the past decades of exploration of Costa Rican field biology. Additionally, virtually all conservation decisions in Costa Rica hinge on the interplay of political and social power, not on complete inventories of biodiversity. For example, it should be made clear that the decision to decree and maintain Braulio Carrillo National Park as a traditional "conserved" national park does not require any further inventory knowledge than that which is already common knowledge among Costa Rican and international field biologists. Whether the Santa Elena Peninsula falls prey to real estate developers and speculators in 1992 will not depend on a detailed list of the species there. Even if that would be helpful, there is not sufficient time to gather it.

Equally important, the goal of the inventory is explicitly not to manage a given national park in the traditional sense of direct protection from the neighbors and commercial interests. A list of 20,000 species of beetles or 4,500 species of plants present in the Guanacaste Conservation Area is not necessary for direct protection management, any more than a fireman needs a card catalogue to extinguish a fire in a library. However, we must simultaneously note that certain kinds of species-specific information will be needed for protective management (analogous to knowing where the Rare Book Section of the library lies and what special visitor conditions should apply to it). For example, the inventory-acquired knowledge that dry forest insects from Santa Rosa National Park migrate to Guanacaste National Park's rainforest refuges in the dry season was used to justify the establishment of Guanacaste National Park, as part of the formation of the Guanacaste Conservation Area.

Had the parataxonomists program been initiated in the 1970's and early to mid-1980's, much of the information generated by the biodiversity inventory might have been used for mega-conservation decisions in those formative years. Additionally, in a limited way, the parataxonomists and their data do still play a role in helping to determine some

of the fine details as to whether this or that set of a few thousand hectares should be included or excluded from a given conservation area.

But today, in Costa Rica, the parataxonomist does not derive his or her primary scientific or budgetary justification from being an essential tool in Costa Rican big-picture conservation boundary planning. However, when it comes to using the area in a manner that does not permanently damage its biodiversity, and therefore generate a powerful counterforce to future wildland elimination by society, the inventory and its associated information is of very great management and budgetary value.

The goal of the inventory, and therefore the daily field work of the parataxonomists today, is deliberately narrowly defined and highly focused by INBio so as to exclude the simultaneous intensive and extensive search for random natural history ("ecology") information about a few capriciously chosen species. To be blunt, the time consumed in collecting most kinds of natural history information is directly competitive with the two initial primary goals of the inventory itself: clean up the taxonomy and locate of the species. Once the inventory is a firmly established process, then INBio will be in a position to begin to invent “paraecologists” and collect natural history information in bulk.

It should be noted also that random collection of natural history data is often less useful in taxonomy than is random specimen collecting. There is no reason to discard easily-recorded information (e.g., labeling material as to whether it was collected in malaise traps, yellow pan traps, etc. or noting that a long series was taken from a drying pool in a dry river bed). However, there is a fine distinction between this kind of activity that takes virtually no time of the parataxonomist, and individual labeling of specimens and note recording, an activity that becomes extremely costly in field time and laboratory processing and generates information of very limited value (e.g., “ sitting on leaf in sun at 10 am in treefall clearing”).

Much of such "natural history" information is traditionally viewed as highly desirable to the taxonomic science community, but it is very difficult to defend the expenditure of major time and dollar resources to gather it when both are in extremely short supply, and the relative value of the information is highly questionable, given the large amount of work to be done in simple collecting of hundreds of thousands of species. To render the gathering of such information cost-effective by field personel requires an additional kind of training, a training that is quite feasible but not yet funded (see below under "paraecologist").

The parataxonomists opportunistically and incidentally learn an enormous amount of natural history information that can be tapped on occasion. The more taxonomically astute and experienced they become, the more natural history information they accumulate on the serendipituously, and the more useful the parataxonomists can be at offering useful replies to ecologically directed questions. But it is one thing to reply to "Have you noticed any species of wild juicy fruits that lie on the forest floor and do not rot", and quite another thing to respond to "Please starting collecting field notes on aspects of plant biology that might offer phytochemical leads". The simple act of rearing a single species of caterpillar can easily absorb an hour a day for several weeks if reasonable field notes are kept on that rearing.

It is evident that another kind of person, a sort of "paraecologist", needs to be developed in parallel with the national inventory. The paraecologist would glean the

forest with the same "directed vacuum-cleaner behavior" as the parataxonomist but specialize on sets of questions and on ways of accumulating information for which the specimens are by-and-large vouchers or being collected in bulk for chemical analysis. Such a person can work very profitably in collaboration with a parataxonomist, and will depend very heavily on field guides, identification reference services, etc. that flow from the inventory. However, it is critical that the parataxonomist does not become subverted into doing very mediocre ecology (as is often the case when when Ph. D. taxonomists become entranced with field ecology) as well as vice versa. The latter occurs less frequently, but is a risk when a paraecologist is confronted by a frustrating ecological question.

3. Collecting agreements?

Each parataxonomist carries an INBio identification card that identifies him to any authority as a legitimate INBio employee and parataxonomist, covered by the appropriate national agreements for collecting inside a national park, conservation area, wildlife refuge, etc. and for transporting biological specimens. By formal agreement, INBio and MIRENEM are collaborating on the national biodiversity inventory. As national biodiversity legislation and regulation become more ordered, as is occurring on a monthly basis in Costa Rica, such formal understanding is critical.

4. What will happen to the parataxonomists when the inventory is completed?

The experienced parataxonomist will always be a hot item on the Costa Rican job market, irrespective of whether the inventory has been completed. Their high level of biological literacy makes them ideal for positions within the agricultural and forestry industries (government or private), and for positions as teachers, ecotourist guides, environmental educators and environmental consultants (government or private). As INBio grows, it also has strong needs for increasingly specialized biologists who are happy to work in the field. The role of INBio is already broadening to include far more than the inventory. INBio itself could today easily hire its own parataxonomists to work as part of the biodiversity prospecting teams if the parataxonomists were not needed for the inventory. By the time that the inventory is relatively complete ten years from now, there will be many parataxonomists who have moved into other areas of biodiversity management (some within INBio and many within the Conservation Areas), gone on to obtain higher degrees, and (even) moved on to other countries as doers and advisers. For example, each conservation area needs someone to manage its research program, and some of the older and more experienced parataxonomists have moved into this administrative role. Equally, each conservation area needs field personnel with a strong knowledge of large groups of plants, insects, birds, etc. to work with the other conservation area staff and to provide on-site taxonomic services for users of the conservation areas. Again, parataxonomists are in a particularly good position to be diverted into this role.

It should be emphasized that becoming a parataxonomist is not a terminal vocation, though some individuals will find it to be a pleasant life-long vocation and show all signs of making it just that. Becoming a parataxonomist is an opening to a diverse set of opportunities in biodiversity management, as well as giving a philosophical background that can be the springboard for development into quite different areas in science and society.

5. What are a parataxonomist's obligations to the program?

It costs approximately $15,000 to train a parataxonomist and support his or her operations for the remainder of the year. As mentioned above, such a trained person is immediately a potential candidate for other jobs in administration, education, public relations, planning, etc. While it would be a major contribution to Costa Rican conservation and society to continually train parataxonomists and then have them leave to take other positions, it might be more effective to train them initially and directly for these other positions. Equally, if all parataxonomists leave with a short time after they are trained, the inventory will take much longer because it will be primarily conducted by relatively inexperienced persons. Being a quality parataxonomist is very much a product of continuous on-the-job training and experience.

From the beginning, the parataxonomist is asked to view himself or herself as joining a long-term vocation program, a vocation in which many years of involvement in the national biodiversity inventory are expected. Successful applicants for the program make a moral commitment at the time to work for a minimum of three years. When temptations to leave appear, INBio makes a serious effort to convince the parataxonomist to stay on as a parataxonomist. However, if the person does leave the program amicably, INBio encourages the person to remain in contact, and does not view the person as a loss either personally or to Costa Rican society.

The work schedule of a parataxonomist is 24 working days per calendar month, for which he or she receives a monthly salary, two weeks of paid annual vacation, an extra month of pay on 1 December, social security benefits, health insurance, free medical services, and a variety of other social benefits as normal for any Costa Rican employee. A “working day” tends to be 6-16 hours distributed through the night and day. The details of the distribution of hours, working days and non-working days is set by the parataxonomist according to his or her perception of the biological characteristics of the focal organisms, and other activities for which society has a calendar. The annual cost to the employer of a parataxonomist is 1.46 X the annual salary. In late 1992, the annual salary of a beginning parataxonomist is approximately $3,000, and the most experienced parataxonomists receive approximately $4,100. This is viewed as a good but not outstanding annual salary for someone in the 20-35 year age bracket with a grade school to high school education in a rural environment.

6. What has been the response of the academic community to parataxonomists?

The response of the academic community to parataxonomists and the concept of parataxonomists has been highly variable. Academic and museum administrators generally say "of course, why not?", but are not inclined to think in terms of facilitating the presence of parataxonomists in the actual field operations that they are concerned with. Many older international Ph.D. taxonomists view them as mediocre field collectors who could not possibly do the specialized collecting necessary in "their groups”. On the other hand, once these people get to know the parataxonomists or work with their collections, there is a strong change in attitude. They then tend to respond to the parataxonomists as individuals and focus on getting to work with their specimens, and on teaching them how to do their particular kind of specialized collecting. Most younger international Ph.D. taxonomists display an immediate response of wanting to work with the parataxonomists in the field “if only they could find the money to go to Costa Rica and do so”.

Some members of the academic community of the developed world have definitely complained "under the table" about the INBio inventory program overall, and specifically about the parataxonomists. "How could they possibly do a ten-year inventory when we have been trying to do inventory for decades, and it is clearly a task of several centuries and demands far more resources being put into systematics." "Inventory, faunistics and taxonomy is out of fashion and no one will fund that." "Oh, we have been using native collectors for years, they are very useful but do not solve 'the problem' which is a lack of funding in systematics". These comments are countered, however, by very positive comments and much help from other members of the international taxonomic community.

There is some resentment that the parataxonomist aspect of the inventory program does not appear to solve the problem of a shortage of employment opportunities for young taxonomists in the developed-world, and that the inventory does not appear to directly address the strong emphasis on cladistics in modern systematics. Taxonomists have for so long been unaccustomed to having to justify their existence to society that they often do not immediately see that inventories and parataxonomists are a way to cause society to be more, rather than less, interested in their profession. Equally, complete inventories should amass mountains of data of use in cladistic analyses. Even more frustrating to the development of the Costa Rican biodiversity inventory is the often felt, but rarely openly stated, resentment-rich comment that "systematics is not the handmaiden of ecology".

Within the community of workers and institutions in foreign development aid, a community that depends heavily on academics as advisors and for new staff members, there have been the somewhat contradictory responses of "oh, that is 'science' and we don't fund science" paired with "oh, you mean a museum. Museums offer nothing to development, social problems or natural resource management and therefore we are not interested in funding that." On the other hand, there have also been a few far-sighted individuals in this community who have been quick to grasp the development potential in explicit biodiversity management for use, and recognize the parataxonomists as an essential and integral part of that use-oriented process.

Within the community of Latin American Ph.D.s and/or university professors, the response to the parataxonomist idea or person has often been a mixture of fear, contempt and resentment. These feelings are often expressed as "why should you give such a good job to some poorly-educated rural person when there are Latin American university students and graduates in biology without a job, and who have worked so hard to get their university degree?" On the other hand, as in the international taxonomic community, there have also been Latin American faculty who have responded very positively to INBio's goals in general, and developing the concept of parataxonomists specifically.

There are both practical and philosophical replies to the question posed above. With respect to the free market, the parataxonomists generally come to INBio with their salaries paid by a government agency or NGO, a commercial interest, or an explicit donor grant (such as that for the female parataxonomists from the Claiborne and Ortenberg Foundation). Any Costa Rican university graduate who shows up wishing to really be a parataxonomist - that is to say, comes with a salary and wants to live and work in a rural environment - is quite welcome. Equally pertinent is the fact that a rural person with less than a university-level formal education is in almost all cases more capable and more

comfortable in the field than is the (usually urban) university graduate. In this context, the university graduate often does not take to the rigors, privations, isolation, irregular and long working hours and days, and primitive working conditions with good humor and a shrug of the shoulders. On average, rural people are also more effective at sharing their knowledge with others in rural areas.

Philosophically, the parataxonomists are clearly a form of affirmative action for the decentralization that is clearly essential for the further development of a country like Costa Rica, where 80% of the power, trained intellect, and decision-makers are concentrated in the Meseta Central (urban zone around the capital city, San José). If there ever was a government sector that is by its very nature decentralized, it is the management for use of a system of conserved wildlands. Costa Rica will never successfully manage its wildlands as absentee landlords. What better caretakers than those people with their social, psychological and financial roots in the very area to be protected?

However, it should be recognized that promoting ruralization of the decision-making processes and facilitating upward mobility of rural peoples encounters strong conscious and unconscious opposition in the capital city and among white-collar workers. The appearance of a group of parataxonomists of rural origin, a group that can perform many of the same technologies and understand many of the same philosophies as can university-level faculty and senior institutional representatives, has been highly threatening to some Costa Rican professors and mid-level government administrators. Careful politicking by INBio staff and INBio supporters in other institutions has been able to only partially defuse this time bomb, and it is not surprising to find that the strongest upper-level support for the parataxonomists and related activities has come from upper level government and university officials.

7. Why are only Costa Ricans allowed to be parataxonomists?

INBio itself is a Costa Rican national institution, and carries with it all the motivation that comes from "pride of ownership" and national identification. As such, it would be highly inappropriate to fill parataxonomist slots with international volunteers (there have been many inquiries to this effect) or employees. Additionally, such activity might speed the inventory, but it would definitely slow the rate at which the conservation areas and their zones of influence come to feel responsible for the fate of their biodiversity.

However, it is also clear that INBio will gradually grow at the ground level to come to be something like an “Instituto Mesoamericana de Biodiversidad”, to nestle its activities up against the bottom of some sort of Mexican INBio-like process to the north (which was decreed on 15 February 1992). This growth will clearly involve the Mesoamericanization of the parataxonomists and their activities, as well as other aspects of INBio.

In fact, INBio is psychologically prepared to begin to admit parataxonomist students from other Central American countries to its courses, provided that there are funds for their support. This immediately begs the question of what insititution will receive and process the material from Nicaragua and Panama. Parataxonomists cannot function without a “mother institution” to receive and process the results of their efforts, and to give them the feedback that they need (see below). INBio is willing to consider receipt and incorporation of material collected by parataxonomists from other Central America, but this implies a massive increase in funding for the remainder of the INBio specimen

and data management process. It also implies an additional major challenge (and cost) in the administration and legislative aspects of biodiversity management, since the solutions being found in Costa Rica cannot be simply and easily transplanted into the social systems of other Mesoamerican countries (though they can be used as pilot efforts).

8. How are parataxonomists and their work evaluated?

There are two relatively distinct aspects to the evaluation of the parataxonomist's performance. One is based on the parataxonomist's response to professional feedback about the quality of material, taxa to emphasize, collecting techniques, sampling patterns, etc. This feedback activity is a major responsibility of the

- INBio curators,
- international visitors to INBio and to the Biodiversity Offices (taxonomists, chemists, ecologists, etc.),
- field liaison between the parataxonomists in their offices and INBio, and
- professors in parataxonomist courses.

This feedback ranges from direct comments on specimens, to telling natural history and taxonomic stories about the species that they are collecting. Short courses, inter-office visits and stays, and maximizing the flow of books and technical papers to parataxonomists in the Biodiversity Offices are all part of the proces. Associated with this feedback needs to be a strong element of encouragement and stimulation to continually probe their own limits with respect to quantity of work, quality of work, self-teaching, learning from associates, and taking full advantage of the short courses that INBio offers. The parataxonomists have generally made a shift out of a long-established friendship circle into a socially as well as technically new world. This is a difficult move, and they need substantial contact with other parataxonomists, other biologists, and biodiversity users so as to not feel isolated in their new vocation. They also need to be treated as professionals, even when they still, understandably, display many of the traits that were adaptive under their former employment pattern. This pattern was generally much more that of a wage-earning employee in a autocratic administrative system, or an unstructured home environment, than that of a professional who designs his or her daily and monthly activities in accordance with a goal-oriented framework. With some very notable exceptions, it has also proven particularly difficult for international taxonomists accustomed to working with university and graduate students to learn how to develop effective feedback between them and the parataxonomists.

Much of the feedback at the INBio facility occurs during a three day period every 2-3 months, when all parataxonomists gather at the INBio and their recently collected material is gone over by the various curators and any visiting scientists that are present and can communicate in Spanish. An evening lecture of general interest also occurs at this time, as well as group discussions of policy and techniques. Parataxonomists also visit INBio opportunistically to leave specimens and get supplies or information.

A program to involve the parataxonomists more directly in the curation process is currently being developed by the INBio curators. Since the curators are themselves new at all of this, and in the process of defining and developing their own non-conventional modus operandi, they have been slow to come to grasp the many ways that they can manage their interactions with the parataxonomists to the benefit of all. However, it has been very striking to watch the curators grow from bystanding observers of the

parataxonomist in 1989 to true leaders of them through one-on-one feedback over the specimens that the parataxonomists bring in at present.

INBio constructed a small 32-bed "hotel" and meeting facility next to the other INBio buildings for the express purpose of hosting the parataxonomists (as well as working visitors to INBio) in these sessions and during short courses. They are not charged for the use of this facility, and it is available to them at any time that they come to San Jose for any purpose.

In the field there is opportunistic, pointed and strategic feedback from the parataxonomist-INBio liason. This position is absolutely critical to the parataxonomist program. In addition to serving as a messenger and materials deliverer between INBio and remote Biodiversity Offices, this liason is the person who sees on the ground just what the parataxonomist is doing. This person has to be an individual and group psychologist, very robust to personal conflicts, understand with absolute clarity the specific goals and general strategy of the inventory and INBio, and enjoy an extremely irregular schedule of long difficult trips, miserable living conditions and uncoordinated crises. Currently this position is filled by the first proto-parataxonomist, Maria Marta Chavarria. She is a University of Costa Rica graduate in biology, the Costa Rican specialist in Gesneriaceae, bilingual, began with a year of unsupervised moth inventory at the La Selva Biological Station, and fulfills all of the above traits.

Throughout the evaluation process and the examination of the material brought in from the field, an impression is formed, person-by-person, as to the relative quality of the work of the parataxonomist. The field liason person also forms an impression of how well the parataxonomist is doing in relations with administrators, neighbors, apprentices, etc. (the liason person is often the first person to flag a potential problem with a parataxonomist, since many problems are less evident in the somewhat academic atmosphere of the INBio facilities). All of these subjective impressions are pooled by the INBio administration and taken into consideration for merit pay raises in addition to pay raises that are automatic with inflation and seniority.

The second aspect of evaluation is that of determining the salaries of the parataxonomists. This is an extremely complex issue:

a) Many of the current parataxonomists have worked for many years as civil servants. When they move into this more professional job climate, the questions of merit pay, individual evaluation by quality of individual work, soft money, intangible benefits (e.g., freedom of full access to INBio facilities, real training programs, independence in the workplace, opportunity for advancement) are new and confusing issues. However, they are well aware of the value of worker's health insurance purchased for the parataxonomists by INBio. This benefit was not easy for INBio to obtain because the government unions do not want to allow the parataxonomists to have what they viewed as favored treatment as compared to other government-employed national park guards.

b) Since different parataxonomists have different employers and different employment histories, it is commonplace for two persons work side-by-side and doing exactly the same parataxonomist tasks to receive quite different salaries. INBio is directly powerless to change this, but has a very large responsibility to attempt to do so. As a stop-gap measure, it has been possible to come to a temporary agreement with the government to be able to give a "sobre-sueldo" (salary add-on) to a government worker to get him up to the INBio salary for parataxonomists. INBio is also very active in

suggesting to directors of the conservation areas what should be the salary for their parataxonomists, especially when they have access to NGO funds to employ part of their staffs. This aggressive behavior by INBio is very important for all parataxonomists because the conservation area staffs are not, at this stage, generally technically capable of evaluating the monthly contribution to the inventory by the parataxonomists.

c) It is standard in Costa Rican society for a person to be paid more if he accepts more responsibility. A basic tenet of being a parataxonomist is working independently, handling his own budgets and funds, setting his own working hours, etc. All of these are traditionally viewed as the symbols of "accepting greater responsibility". However, the particular employment structure in which most parataxonomists are imbedded has no interest in recognizing this "greater responsibility" with a salary increase. The outcome is a parataxonomist getting up at 4 am to collect insects at a light while his park ranger colleague snores peacefully in a warm bed, with both of them receiving the same salary.

d) Costa Rican salaried wage-earners commonly belong to real or informal unions. A basic tenet of these unions is that if the salary of one person rises, the salary of all rises. For the first year of the parataxonomists, they steadfastly maintained as a group that they did not want pay raises for one if it could not be achieved for all. INBio argued that the best it could do would be to work on those employers where it could cause salary raises. The parataxonomists finally broke their own informal "union" and came to agreement on that policy. This decision carries with it, however, the moral obligation that INBio be extremely dilligent in its efforts to equalize salaries - in effect to become its own union.

e) Institutions generally have their directorates centered in an economic class that is not accustomed to fighting for higher salaries for their working-class employees. INBio has long recognized this problem and worked very hard to accept the responsibility of pursuing benefits for its paraprofessionals with the same vigor as they do for the administration and science staff. It is, however, an uphill struggle, both because of the perennial shortage of funds and because of the society-wide tendency to feel that people lacking formal higher education should be not be as well paid as those with higher degrees.

f) As the parataxonomist develops, he or she becomes thoroughly exposed to the life style, thoughts, issues, and ways of analysis commonplace to decision-makers in Costa Rican society. He or she logically applies these new tools to his or her own circumstance, and applies it to what has been a primary preoccupation for all his or her life - the monthly paycheck. The parataxonomists are at a salary and life style level whereby changes in monthly pay of as little as $20-$50 are relatively large changes and can strongly affect performance. Parataxonomists are chosen for their (generally unrealized) ability to be thinkers, act independently, and chart their own course. It only takes about two seconds to come to the partly correct conclusion that if the parataxonomist is doing the field work that is normally done by university graduate, then a parataxonomist should be rewarded accordingly. This quite justifiable attitude means that INBio has an obligation to be continually in search of funds to increase parataxonomist salaries over and above the costs of training and employing yet more parataxonomists. This phenomenon is a particular case of the general case that in tropical conservation development, what initially appear to be quite low management costs increase very rapidly as an undeveloped country begins to develop.

g) For numerous parataxonomists, this is the first time that they have worked for a salary or an employer. These parataxonomists are more inclined to accept whatever is the pay structure as a fact of life, and INBio generally has the opportunity to set that structure at a reasonable level from the beginning. For these persons, however, the concept of being responsible and responsive to INBio, in return for a paycheck as well as a host of intangibles, is a new living experience. It creates quite amazing mixes of people putting in 18-hour days until they drop from exhaustion combined with being perplexed when they find that they cannot take off for several days on the dark of the moon - a particularly important time for collecting with lights - for their mother's birthday. Equally, the concept that one really has to listen to some unpleasant criticism of the quality of one's work, instead of being able to simply shrug it off as "my way of doing things", falls as a quite strong shock to some.

h) Costa Rica is an extremely poor country in comparison with the developed world (per capita GNP is 10% of that of the US, the national budget is $1 billion, or about that of a good US university). Its population is currently about six times as great as the carrying capacity for persons with a developed world standard of living. There is simply no fat Costa Rican government budget somewhere that can be asked to pick up the cost of bringing the trained parataxonomist up to what he or she should be paid. Worse, there is no way to then simultaneously raise the salaries of the others who work in the same biodiversity management structure (curators, coordinators, directors, and other major decision-makers). The start-up capital may come from the international development community, but the long-term operation is going to have to be covered by biodiversity user fees in one format or another.

9. What is the function of the short courses for the parataxonomists?

The basic six-month parataxonomist course is designed to give an overview understanding of how to conduct the base of the entire inventory process, and get the parataxonomist to where continued on-the-job training will provide the needed upgrading. Detailed and very specific knowledge learned in the basic course is generally to illustrate a particular process or technique, rather than to be everything one needs to know for intense collecting and understanding of a particular large taxon. Additionally, there are many species-rich groups of organisms that demand an intense short course in collecting and preparation techniques, methods of distinguishing among species, natural history, etc. To date, short courses of 2-60 days duration have been held with marine invertebrates, beetle families, Chrysomelidae, microlepidoptera, Hymenoptera, spiders, Tachinidae and Syrphidae, higher plants, ferns, aquatic insects, and mites. Mites, Diptera, families of small beetles, lower plants, protozoa, fungi and small reptiles and amphibians are evident candidates for additional short courses.

The short courses also, however, are also an opportunity for the parataxonomists to work together, to see more intensely how international scientists work and think, and be in direct contact with INBio for periods of weeks. During this time, in addition to taking the course, they also converse much with the curators, look up things in the collections, and generally participate in the atmosphere of INBio as a central information clearing house. The short courses are taught both in INBio, and in one or more conservation areas.

The short courses also serve as a mechanism for an intense field and laboratory exposure of the parataxonomists to collaborating international taxonomists and vice-

versa. To date, these collaborators have expressed strongly positive reactions to their experiences of working with the parataxonomists. INBio has been extremely fortunate that there have been a small number of international taxonomists willing to give up their field research time and deviate from their more traditional taxonomic pursuits to teach in the advanced courses. It has been even more fortunate that their administrators have let them.

The length and location of short courses depends strongly on the particular group to be studied and on the particular taxonomists doing the teaching. For large and diverse groups such as Hymenoptera and microlepidoptera, the most satisfactory structure appears to be three faculty members over two three-week periods, with one faculty member present throughout and the other two each visiting for one of the three-week periods.

10. How does INBio get international taxonomic cooperation for the training of the parataxonomists?

INBio recognizes that for a taxonomist to feel free to participate in training of parataxonomists in Costa Rica, there must be some kind of clearance from the directorate that pays his salary and evaluates his performance. In this case, a major INBio task is communicating with that directorate, or helping the taxonomist communicate with that directorate. There is no free lunch. But there are many coinages.

Second, one has to recognize that only a select subset of the international taxonomic community will want to come to Costa Rica and spend time teaching in Spanish what amounts to a high school class, rather than going off and collecting some favorite group of organisms. The trick is to focus on those high-yield individuals who express serious interest, and facilitate them. This of course means that the particular groups of organisms that receive emphasis at present will represent the accidents of which taxonomists are interested in participating, rather than moving systematically down a mind-numbing list of taxa to be covered. So be it. There is an excess of things to do now with the groups where there are enthusiastically interested international taxonomists, and over time specialists in other groups will appear.

Third, the specimens and knowledge that is accumulated by the parataxonomists become part of the reward for the interested taxonomist today, and create the interested international taxonomist in the future. When it becomes known that there is a body of parataxonomists here ready to be told how to collect mirid and lygaeid bugs, for example, and that they have already collected thousands of specimens of them, there will magically appear a person who decides that mirid and lygaeid bugs of Costa Rica are more interesting than the pentatomid bugs of the US on which he works at present.

Fourth, when the taxonomist comes to Costa Rica to collect on his own group, with no interest in being involved with the parataxonomist, INBio should welcome him or her with open arms anyway. But INBio should also 'accidently' leave a lot of specimens belonging to his group, collected by the parataxonomists, in plain view, so to speak.

Fifth, approach the international taxonomist with the offer of an INBio search for a curator to work with him or her, in return for guidance in his or her group for that new curator. This strategy, however, demands a financial source to cover the costs of more Costa Rican curators, a source that INBio has not yet located. Today's INBio curators are

barely surviving on a miscellany of soft money from NSF and AID grants, and private donations.

11. How are the courses funded?

As mentioned previously, the first two courses and the costs of establishing the parataxonomists for their first year of work were supported by US-AID through the Biodiverisity Support Program. The University of Pennsylvania has donated Janzen's salary. Winnie Hallwachs, numerous visiting entomologists and botanists, and curators of INBio have donated their time. The GCA has donated a wide variety of goods and services. In 1990, the Pew Charitable Trust donated $300,000 to establish a parataxonomists teaching endowment. This donation was converted through a debt swap to $1,321,171 in dollar-denominated 20-year government bonds (paying 3%/yr in dollars, converted to colones at the current rate of exchange before payment). This debt swap was conducted by INBio and Solomon Brothers with fiscal and advisory assistance from the Fundacion de Parques Nacionales, the Central Bank, the Swedish Government, MIRENEM, The Nature Conservancy, WWF-US, and the Biodiversity Support Program of US-AID. This fund generates about $35,000 per year. The interest income and principal are exclusively dedicated to teaching the basic parataxonomist courses.

As mentioned earlier, the funding for the third (female) parataxonomist course, currently in session, comes from the National Fish and Wildlife Foundation, the Moriah Fund, the Conservation, Food and Health Foundation, SIDA of the Swedish government, and INBio's Pew Teaching Endowment.

INBio clearly needs substantial additional funds for teaching the basic courses to the new cohorts of parataxonomists over the next few years.

When discussing the costs of the basic course, the question often arises as to whether it really needs to be six months in length. We have two reasons for responding with an emphatic yes. First, a shorter course was tried with the second parataxonomist course and did not work. Second, as we come to understand the many very different things necessary for the course content - technology, personal adjustments, theoretical understanding, philosophical understanding, supervised practice, all of these things in a number of habitats and two seasons - it is clear that six months is an absolute minimum. It must be remembered that the course takes people who have completely abandoned the formal education track and all that implies, and moves them back into what it demands at a much later age. Every single student turns out to have major and different debilitating personal, technical and/or physical traits that need some modification in order to become a parataxonomist. These weaknesses exist, and to some degree may even be the causes, in spite of extreme competence and enthusiasms in other areas of their lives. Often these weaknesses were the very traits that took the student out of the formal education track and moved him or her into a daily labor job or home responsibility; some examples are fear of learning, family opposition to schooling, work responsibilities, bad eyesight, etc. Each of these weaknesses has to be rectified or adjusted to be compatible with a parataxonomist's performance. This takes both substantial amounts of group time and absolute time. Equally difficult is that some of the weaknesses do not make themselves evident until the student has advanced to a substantial degree. This is not so much because weaknesses are deliberately hidden, but rather that one has to have developed a certain package of skills before one discovers that some other seemingly quite unrelated

trait impedes the further development of those skills. Finally, there is enormous heterogeneity in the rate at which any given student advances in any particular capability.

The 2-month advanced courses were funded by the National Science Foundation as supplemental awards to the "Moths of Costa Rica" inventory grant, and were focused on two groups of central importance to Costa Rican Lepidoptera - microlepidoptera and Hymenoptera (as major parasitoids of Lepidoptera). However, faculty salary and time were donated for these two courses by the Natural History Museum (London), Systematic Entomology Laboratory of the USDA (at the US National Museum of Natural History), and the University of California at Berkeley. Supplies and equipment for the courses was donated by US-AID, NSF, University of Pennsylvania, University of California, University of Minnesota, Cornell University, British Museum (Natural History), USDA, Wege Foundation, Pew Charitable Trust, MacArthur Foundation, W. Alton Jones Foundation, Noyes Foundation, The Nature Conservancy, WWF-US, SIDA (Sweden), private donors, and the government of Costa Rica (GCA and MIRENEM).

Funding for the various shorter advanced courses has been cobbled together from private donations and scraps out of other project budgets. Funding for future advanced courses is desperately needed.

12. What are the parataxonomists actually producing today?

A representative unspecialized parataxonomist generates during the course of a month 20-30 plant collection numbers, 1,000-3,000 properly pinned and mounted insects, and large counted numbers of insects in alcohol from Malaise traps, interception traps, yellow-pan traps, etc. When the parataxonomist is instructed to focus on particular groups, the overall number of specimens declines to some degree, but the needs of the inventory are more strategically met.

All specimen preparation is done in the field. That is to say, pinnable (or point-mountable) insects are delivered to INBio mounted and ready to be labeled (labeling is done by labelers trained for this routine task at INBio). The parataxonomists are trained to discard material for which there is no time to mount in the field. Such a philosophy is a dramatic departure from the time-honored tradition of bulk-preservation of large samples in the field during a collecting “expedition”, samples that are later slowly mounted in the home institution at great cost in technician time (major museums in developed countries have very large deposits of such samples dating from as far back as the turn of the century). Alcoholic samples from traps are sorted at the Biodiversity Offices to whatever degree is requested by the INBio insect-processing system, and then delivered to INBio for freezing until they are further sorted by a specialist. An INBio-UCR sorting center is currently planned for large bulk samples from insect traps.

In September 1991, the decision was made to ask eight of the parataxonomists (at that time) to specialize on plant collecting, to facilitate the termination of the “Manual of the flora of Costa Rica project” being jointly conducted by the Missouri Botanical Garden, INBio and the Museo Nacional. The remaining 15 (at that time) parataxonomists began on that date to specialize for a year on 12 major groups of insects, as a way of facilitating the work of a set of international taxonomists who have agreed to put a substantial effort into “doing” these groups for Costa Rica.

INBio has just finished a modern earth-quake proof building to house the arthropod collections and herbarium, and working space for the arthropod and plant processing systems. Given this facility, the primary operations cost for the parataxonomists in their

daily activities is providing them with minor personal supplies and specimen processing supplies, and then supporting sufficient processing and curational activity at INBio to handle the in-coming specimens.

The parataxonomists are now also producing apprentices that are drawn either from school groups that visit their biodiversity offices or enthusiastic individuals living in the immediate area. These persons generate more specimens today (with an associated cost in minor equipment, supplies and time) but more importantly, will be future sources of parataxonomists. Three such persons are among the students in the third parataxonomist course.

13. What will be the actual cost of the parataxonomist component of the Costa Rican biodiversity inventory?

A rough calculation of what it will cost to get the specimens and associated information for Costa Rica's half million species into a standard inventory format and into the front door of INBio is $21,927,050 spread over ten years ($2,192,705/yr). This is based on the actual costs and experiences during the past 2.5 years of operations of the program, and certain non-inflationary cost rises that are happening in Costa Rican society (e.g., current salaries in Costa Rica are far below what an educated and cosmopolitan society demands on the free market). This is $43.85 per species, for roughly 4% (500,000) of the species contained within the world's biodiversity. Once the material and information has arrived at INBio, the further processing, identification, and information management cost is roughly 1/2 that of the cost of obtaining them. A safe estimate for the total is $30-32 million in today's dollars. The largest uncertainty associated with this figure is the cost of locating and isolating the tens of thousands of species of microbes.

14. Why expend funds on the vocation of parataxonomist, when the same funds could be used to fund taxonomists to get on with their taxonomic revisions?

First, this is not an either or situation. There needs to be a body of curators, taxonomists, and other kinds of information processors generated to handle the parataxonomists' output. Second, the international taxonomists (systematist) has had centuries to get the world's biodiversity in nomenclatorial order. While they have done much, there are still many centuries worth of work left to do if we continue at the current pace, style and tradition. While this document is not the place to analyze this topic, it is clear we must have a partial shift from a taxonomist who spends an entire lifetime monographing a group from Alaska to Argentina, to some kind of a combination of monographic work with regional or local faunal and flora works. Without these regional works, all the rest of the biodiversity user community has its hands tied. And if there are to be regional works, then one needs an inventory of what is there so as to know what to put in the regional work. To use Ph.D. taxonomists for the basic muscle and brains of this inventory is to ask a mouse to gnaw down a tree instead of using a beaver colony. Even if enough funds were available to train a very large cohort of Costa Rican Ph.D.s in systematics to handle first Costa Rica and then the rest of Central America, the many decades that it would require are not available. And even these Ph.D.s would quickly decide that their time was better spent on detailed and background-demanding systematics and cladistics, leaving the time-consuming field inventory work to people who are the equivalent of parataxonomists.

Second, the act of using the very populace that threatens tropical biodiversity to inventory it and put it to work, is to take a serious step in the direction of both putting the

fate of tropical biodiversity in the hands of those who own it and causing them to understand what it is. What is the probability that university professors will suggest pulping university libraries the next time there is a paper shortage in the US? Biological literacy by the general populace is probably the only really long-term solution to tropical conservation problems.

15. What characterizes the persons who have left the parataxonomist program?

Of the 32 parataxonomists in the first two courses, 13 have left the program as of late 1992. There have been four reasons for leaving:

- resigned to return to a former life style (3 persons),
- attracted to a university degree program (1 person),
- attracted to another kind of biodiversity management position (biological illustrator, INBio curator, education program, conservation administrator) (5 persons) and,
- removed from the program for poor performance (4 persons).

There is virtually no chance that the 19 remaining experienced parataxonmists will abandon work in biodiversity management. Perhaps as many as half, however, may well move upward or laterally at some time into higher education, administration, taxonomy or teaching positions.

16. Why were there not more female parataxonomists in the first two courses?

Every woman who has applied to the first two parataxonomist courses - all three of them - were accepted. One then went on to high school and the other two are still outstanding parataxonomists. There is a major problem in that there are very few salaried women in the rural labor pool from which the parataxonomists are chosen (as noted above, the parataxonomists have been recruited from people who are paid by other sources).

As mentioned previously, owing to a generous grant from the Claiborne and Ortenberg Foundation, this situation has now been rectified with the third course. With salary funds in hand, INBio can hire directly from the rural community rather than having to depend on donated positions from the government. All signs are that rural Costa Rican women can be excellent parataxonomists.

17. What will be future major problems with the parataxonomists?

As Costa Rica's biodiversity management program reaches maturity, it will be viewed as a serious competitor by some sectors of the developed world. These sectors will both compete with and aggressively attempt to destroy or retard the program (as some are already doing). As biodiversity management programs become commonplace in the tropics, this reaction will also become more widespread and intense. A truly efficient and sustainable tropical biodiversity management program threatens traditional national park concepts, biodiversity ownership or use hegemonies, foreign aid traditions, and many other favorite sons of the developed world. The developed world will not sit back calmly and watch its place in the limelight be taken away from it (witness the arguments over the Yucatan to Yukon trade barrier readjustment, and the political pressure directed at US-AID for funding that may cause job flow from the US to the developing countries).

At present, INBio in general and the parataxonomist program specifically depend on much financial and some political support from international aid agencies, developed world foundations, and private donors in the developed world. The more a program builds itself and the more a program narrows the socioeconomic gap between the donor and the recipient, the less these funding sources are interested in helping. INBio walks

the razor edge of demonstrating extreme need out of one side of its face and success out of the other. The donor community demands that INBio be extremely needy yet be extremely successful with what it is given, a success that in turn automatically lowers its neediness in the eyes of the donor. The parataxonomist program has had to live with this reality from the day of its inception, from the level of the individual park guard who is denied a pay raise because "he has received the enormous freedom of work bestowed on the parataxonomist" to the entire program being denied funding for operations because it is not "grass roots agriculture" but rather "scientific".

18. What has been the single largest obstacle to the development of the program as a whole?

Lack of understanding of what the parataxonomists are and what they represent by people of all levels - from they themselves to their former peers to the highest decision makers.

19. What has been the single largest obstacle to the training, development and professionalization of the individual parataxonomist?

Leaving behind, or being allowed to leave behind, their former life and fully enter this new vocation and the broad social ambit that comes with it.

INBIO CURATORS AND COLLECTIONS MANAGEMENT

The traditional pattern in tropical taxonomy and inventory has been, and still is, for international taxonomists to do much of the collecting in the field and take the material back to their developed world museums and universities (irrespective of token deposits of material in tropical national collections). Additional material is purchased from a very small number of local collectors who specialize in this kind of livlihood. A few tropical countries have been fortunate in having residents who carry out some of this work on their own (e.g., Mexico, Costa Rica, Venezuela, Brazil, Peru). In effect, the highly international developed-world institutions are operating like diffuse world-wide INBios that focus on the collection, curation and taxonomic activities of an inventory, an inventory conducted at a pace that is determined by the budgets, personal interests, commercial interests and academic traditions of a small number of developed world countries. It is through the dilligent application of this activity for several centuries that there is today a substantial taxonomic framework on which to build a tropical biodiversity inventory.

However, the emphasis has been largely on monographs oriented toward a major taxonomic unit throughout its geographic distribution, rather than on regional or national field guides, focused identification services, regional or national centers of specimen and taxonomic management, and generating local taxonomic ability. Tropical ecologists, agriculturalists, medical entomologists, etc. do depend on this international community of taxonomists to do their identification and taxonomic work for them. However, in most cases, users of extant taxonomic services seek the identification of a relatively small number of focal organisms rather than of megablocks of biodiversity as a whole. These users are also an important part of the entire system of inventory-identification-taxonomy through the provision of specimens, natural history data, and user feedback on identifications. However, today, a new kind of user is appearing, one that is concerned with very large blocks of biodiversity in which no particular species is sufficiently focal to attract major resources at the time of identification.

It became immediately clear to INBio that an inventory generated by the parataxonomists program could easily generate enough material to swamp any and all taxonomic service capacity available from the developed world for Costa Rica (an estimated 365,000 species of arthropods and millions of specimens). Equally daunting was the fact that the taxonomic service capacity of the world has a responsibility to, and enthusiasm for, much more than just Costa Rica. INBio therefore set out to 1) do everything possible to facilitate the work of the international taxonomic community whenever it was feasible for them to work with Costa Rican specimens, 2) begin a massive, if goal-directed, effort to train Costa Ricans with basic university degrees in biology to do as much of this curatorial, and eventually taxonomic, work as possible, 3) attract international taxonomists to be very active on-site participants in the entire specimen processing system within INBio as a start-up investment, and 4) define and realize a new kind of curatorial profession that is oriented toward a specific set of INBio products rather than toward the maintenance of a "museum" and direct generation of taxonomic monographic work per se. The inventory and collections aspect of INBio are just two steps in a long progression from the living organisms and their biology in the conservation areas to the users of this information, rather than finite ends unto themselves.

This set of four goals then lead to a definition of the INBio curator as a new profession that incorporates many characteristics and activities that are traditionally assumed by a variety of other persons, as well as by traditional curators, in the international taxonomic community and its interactants.

We beg patience by the international taxonomic community in reading what is presented here. Many of these comments are widely known, debated and understood by you, but not to the remainder of society. It is impossible to write a document that touches only on your most pressing (and often in-house) concerns, yet simultaneously conveys the whole panorama to society at large.

Source of INBio curators.

The traditional source of taxonomists is persons with a deep personal interest in taxonomic biology, and often in a particular group of organisms. However, if tropical countries wait passively for such persons to appear spontaneously from their own populace, experience has shown that sufficient numbers do not appear. Second, if the surplus from developed countries performs this function throughout the tropics, development of self-sufficiency and a sense of responsibility for national biodiversity is severely retarded. Tropical biodiversity simply does not have several centuries available to wait for home-grown taxonomic capacity to appear as a serendipituous consequence of development, especially when the development of biodiversity resources can be one of the major pillars of national development.

In the case of Costa Rica, the universities generate a steady flow of Bachelor's Degree graduates in biology, many of whom find the curatorial position to be an attractive career if it can be developed through on-the-job training. Equally, there are already many persons working in other biology-related fields who would be happy to change into a biodiversity curatorial career. There are several hundred groups of Costa Rican organisms that are large enough to offer several decades of curatorial career specialization. The limit to the number of INBio curators is therefore set entirely by the availability of salary and operations costs. Through a system of apprenticeships and on-

the-job training, anyone with enthusiasm and university-level education in biology can become productive immediately.

The enthusiasm for being a curator is strongly linked to the curatorial profession being viewed as an honorable and highly valued occupation per se, rather than as painful drudgery accepted as the price one pays for an institutiona home to pratice the taxonomy one loves. Ironically, one of the largest barriers to becoming a happy curator is the presence of a very large number of international taxonomists for whom resentment of curatorial and identification activities are the unstated hallmark of a "true taxonomist". The international taxonomist has an immensely valuable role to play in the apprenticeship and on-the-job training of INBio curators. However, with the exception of a very few individuals, it has proved extremely difficult for these same mentors to come to accept that the goal is the production of national tropical self-sufficiency and national curators who can conduct this, rather than production of more graduate students on their way to becoming members of the international taxonomic club as defined over the past several centuries. We are asking one religion to be collaborative in the production of the members of a new religion that incorporates many of the same tenets, but differs in some very fundamental ones.

What do INBio curators do?

The INBio curator lives a daily regime that is an extremely complex mix of social and asocial responsibilities. Some of these are listed below. One salient characteristic of a successful INBio curator is an ability to prioritize among many competing demands, and the ability to organize with respect to overall institutional goals. It is clear that each of the activities listed below could be a full-time job unto itself, and may eventually become so for a given taxa at some particular time. However, funds are not available to hire a sufficiently large number of persons to so specialize, and many of these responsibilities have the property of being intrinsically small for a long time, and then requiring intense dedication over a short period. For example, the specimens and information for a field guide may require five years to gradually accumulate, and then abruptly be fashioned into an actual electronic copy with several months of intense work.

1. Oversee incoming specimens from the parataxonomists and ensure that they are moved through the process that generates correct labels, places the labels and moves the specimens into the sorting process. This process is normally the responsibility of a single person at any given moment. It is tailor-made to the particular conditions of INBio (e.g., there are no museum dermestids in Costa Rica and INBio is desperate to see that they do not enter with material from international collections, INBio's collections need to be earthquake proof, all specimens are individually bar-coded and processed, etc.).

2. Oversee and conduct the sorting process that generates the taxon-oriented batches of specimens to be further worked on by the curators and international taxonomic specialists, or sent off to the latter.

3. Provide organized feedback to the parataxonomists, at INBio in group and one-on-one sessions, and at the Biodiversity Offices. This feedback is focused on the curator's taxa, but also touches on general aspects. The feedback treats subjects such as what groups to emphasize and demphasize (both within the curator's taxa and for the inventory as a whole), techniques, natural history, logistics, taxonomic ability by the parataxonomists and solidarity with a larger system. In most cases, neither parataxonmist nor curator is driven by deep passion for a particular taxon, but rather by more usual

kinds of human-human social interactions. This feedback also includes fostering, evaluating and advising on any awakening interest by the parataxonomist in accepting broader responsibilities in administration, taxonomy, public service, further formal education, etc.

4. Curate the curator's taxa to the best of his (ever-increasing) ability in the INBio reference collections. Insure that the computerized data bases for these taxa are as up-to-date as possible not only with respect to specimen data but also with respect to the information management programs that manipulate this data into juxtaposition with other kinds of data and processes.

5. Work with international taxonomists (in Costa Rican and abroad) in his taxa to facilitate their work with these taxa, attract their interest to these taxa, extract from them taxon-specific and Costa Rica-specific information and understanding, and encourage specific Costa Rica-specific products.

6. Conduct direct identification services for INBio users to the best of (the increasing) ability of INBio. Such services range from the actual stimulation and production of field guides to teaching users how to use the reference collections to making the identification directly to sending a specimen off to an international taxonomist and getting the name back to the user.

7. Insure that his work and processes are sufficiently well-known and understood to the remainder of the INBio programs such that they are making full use of the curator's processes in their activities of biodiversity prospecting, information dissemination, information processing, etc.

8. Be willing to move on to other major taxonomic groups as a given taxon reaches a state of relatively thorough inventory. This may involve also maintaining only a part-time curatorial responsibility for updating and facilitating others' work with the "finished" taxon. Alternatively, it may be more important for the curator to move into some other area of INBio information management (e.g., ecology, behavior, biodiversity prospecting, electronic data management, etc.). In all of these cases, it will be extremely important for the curator to place his or her responsibility to INBio's activities as a whole above a particular taxonomic interest. Of equal importance must be an INBio willingness to do everything possible to take into account the curator's interests in decisions as to allocation of his time.

9. Insure that all of the above is done in such a manner that Costa Rica develops a sense of taxonomic self-sufficiency, whereby it feels confident that taxonomic problems and identifications are not an obstacle to the use of biodiversity, and that the incoming biodiversity information is being placed in a stable taxonomic framework.

Regionalization of curatorial activity?

While INBio is a national institution, there are many logical and some political pressures for it to become regional, a sort of Central American INBio. While parataxonomists tend to be wedded to a particular site, and international taxonomists are already international, the INBio curators will definitely be caught in a tug-of-war between increased quality and depth in-country and broader scope regionally. Some of the conflicts can be resolved with simply greater budgets and more curators, and better communication technology and more political will. But there are other more personal conflicts. A Costa Rican curator can be the curator of Costa Rican macromoths with almost no disruption of a normal family life, while a curator of Central American

macromoths is taking on a highly nomadic existence for several decades. A curator may work very hard for biodiversity dissemination within his own society, but be much less inclined to do the same for peoples in other countries. On the other hand, as (and if) INBio becomes regional, there is increased reason for some curators to specialize to where they are in fact international taxonomists as well as Costa Rican in emphasis.

To expand the Costa Rican national inventory to that of Central America also means a major headache as to budgetary responsibility, ownership of the information, and distribution of the commerical returns from biodiversity information. An INBio and its curators can of course become a kind of custodian for Central American biodiversity information, but to take on the enormous cost of such an effort will require financial and political backing of a level that is clearly not present today. And if it were, it is possible that each of the Central American countries would want to have its own INBio.

How do INBio curators differ from graduate students and Ph.D. taxonomists (and curators) in museums in the developed world?

First and foremost an INBio curator's goal is to directly facilitate the use of Costa Rican wildland biodiversity information by society in such a manner that the user community both supports the direct management costs of the wildlands containing that biodiversity and contributes enough to the GNP that society recognizes wildland biodiversity as a productive sector. The curator is a key element in the translation of raw biodiversity information into items that society is willing to pay for in cash and barter. The same is true of the graduate student and Ph.D. taxonomist curators in a developed world museum, but in the developed world there is so much social distance and bureaucratic tangle between the raw material (the bug in the woods) and the final product (a new strain of seed corn) that the developed-world curator is allowed, and even forced, to isolate himself from the process overall.

One outcome of this great social and bureaucratic distance has been the transformation of "getting a degree" into an end in itself. Worse, as presented to the tropical citizen peering into the halls of academia, the "degree" becomes a ticket to greater personal resources (prestige, power, salary, job security, etc.). The outcome is that the INBio curator is under constant peer pressure to "get a higher degree", both from his Costa Rican age cohort subject to this general phenomenon throughout all walks of life, and more difficult, from his international taxonomic mentor. The latter is caught in a trap of measuring his success in <u>his</u> world as "mentor to an apprentice" against the yardstick of whether he "has a Latin American graduate student coming along" and therefore is thought of as "doing his part for tropical biodiversity", rather than against the yardstick of how effectively the INBio curator is fulfilling INBio's goals. The international taxonomist is also caught in a yet more tender trap when he or she finds in the curator someone who fulfill's the taxonomists dream - a bright and eager apprentice desirous of following in the mentor's footsteps and really become a specialist in some group (of which the number of specialists in the world is probably 1-5). It is almost impossible to resist encouraging the curator to follow the mentor's footsteps, rather than to stand aside and ask just what it is that the curator needs to be in order to be really on top of INBio's goals.

A partial solution lies in developing collaborative programs between INBio and Costa Rican universities whereby the INBio curators receive MS Degrees as recognition of the work that they do as curators. An unfortunate impediment to such a solution is the

extreme conservatism characteristic of developing-world universities coupled with the very real sense of professional threat that university faculty and student bodies express about the entire INBio staff that is conducting the national inventory process.

Another solution lies in the gradually increasing dissatisfaction by society in general with academia science's tendency to avoid working for direct and pragmatic solutions to widespread social problems. The Costa Rican university that begins serious collaboration with INBio and other similar problem-oriented institutions, be they private or government, should receive substantial approval from society at large. Likewise, the parataxonomists, curators, biodiversity prospectors, and other novel categories of INBio staff will all be the benefactors of such a collaboration. Additionally, the two major limits for curator participation in short courses, seminars, trips abroad to work with specialists, etc. are the number of hours of the day and the direct operations costs associated with these activities.

INBio curators also differ from graduate students and Ph.D. taxonomists in that their training is focused on the nine major activities listed earlier, rather than on the training appropriate for an academic taxonomist in a developed-world unversity or museum. Not only does the training differ in kind, but also the INBio curator is generally uninterested in leaving family and society for multi-year periods of graduate training abroad. Even in those cases where the curator would be willing, INBio specifically, and Costa Rican biodiversity in general, cannot afford the luxury of supporting 7-10 years of foreign academic training for each curator. On the other hand, a great deal of on-the-job training is an ongoing and necessary part of developing a curator's technical ability. An equally large amount of experience is necesssary to maintain his interactive skills finely tuned and appropriate to an ever-changing challenge.

What do INBio curators need to do their work?

The costs of maintaining and facilitating INBio curators are largely self-evident from the nine activities listed earlier. However, it is critical that the curators do indeed have these resources. The "traditional" curator may be able to do his job with little more than the collection itself, access to a good library, and an occasional trip to examine types. However, the INBio curator needs access to field vehicles to give feedback to the parataxonmists in the Biodiversity Offices, high quality GIS and data base workstations for both his own speciality group and for information dissemination, travel costs for self-directed learning and work with international taxonomists at their home institutions, and operating funds to keep the processing of incoming specimens fully up to date. Equally, the INBio curator needs to be backed up by a fully-funded publication process (hard copy and electronic) to insure distribution of the information gathered. He or she also needs support funds so as to be able to host visiting international taxonomists in the field in such a manner as to extract a maximum amount of information from them and cause them to willingly enter into this entire inventory process. In the ideal world, the INBio curator may even have access to a funding process that can fully support international taxonomists for periods of very intensive work quite focused on Costa Rican members of their group. There is a strong need for taxonomic consultancies aimed at the production of specific products (guide books, reference collections, massive amounts of alpha descriptions, etc.).

What are the primary barriers to the development of a fully functional INBio curatorial staff?

Assuming that funding becomes available for salaries and operations, and assuming that Ph.D.s can learn to resist attempting to turn the curator into yet another Ph.D. in taxonomy, the major deterrent to full curator development, as well as to much of the inventory/identification process, is the very great fear that the developed world taxonomic community and its core institutions will lose their world position of scientific and pragmatic dominance in the management and traditions of biodiversity taxonomy. This fear is expressed in a multitude of thinly-veiled ways, and has at least three main elements: a deeply rooted elitist view of taxonomy (expressed in statements such as "taxonomists are not the hand-maidens of ecology"), a normal social fear by developed countries of loosing their world dominance through true development of the undeveloped (tropical) countries, and a highly personal fear by many taxonomists of having to become highly goal-directed and directly responsible for their actions (or lack thereof). A particularly striking example is to be found in the present day effort by the developed world science community, and its ambassadors throughout the tropics, to plan and develop a world-wide system of gathering and disseminating biodiversity information. This effort from the very beginning is characterized by being rich in hopes and directions based on free information flow (to, for what is for all intents and purposes, the developed countries) and very impoverished realism about how the economic interests of the developing countries are to be protected.

This fear means that the taxonomic institutions and personnel of the developed world approach the entire subject matter of these guidelines with great trepidation, and generally need to be led into them rather than eagerly seek a highly collaborative relationship. This reluctance has a distinctly dampening effect on the young, insecure, and exploratory nature of both the INBio process in general and the development of the curators specifically.

INTERNATIONAL TAXONOMISTS

The entire INBio process has been nurtured from its beginning, and well before, by a very small number of heroic international taxonomists who have put their intellectual and moral support to the process described here. These pioneers have been extremely important in not only actual INBio products to date (parataxonomist courses, curator training, guidebooks, collections management, computerization, government advice, etc.) but also in giving insight into what are the things that can make participation in the INBio process more attractive for the international taxonomist.

How to attract international taxonomists to an INBio-like process.

1) Develop good relations between INBio and the taxonomist's home administration, relations aimed at having the home administration value the taxonomist's participation in a quite unorthodox process.

2) Focus attention on taxonomists that are the top taxonomists on their particular taxa, and also intrinsically enjoy their organisms and their natural history.

3) Examine with care the logistic, administrative, financial and psychological needs of the specific taxonomist and focus on meeting these needs, rather than treating taxonomists as a highly uniform category, all with the same view of what is a scarce resource. With one person the right thing may be help to find an airplane ticket to study types. With another person it is help with a difficult department chairman. With another it is help in writing a major proposal for funding of both the INBio process and the taxonomist's home institution.

4) Recognize that time is an extremely valuable resource to an international taxonomist; the developed world citizen has an extremely difficult time appreciating how frustrating it is for a person to have to spend several of his few days in a tropical country dealing with meaningless bureaucracy.

5) Recognize that there is almost nothing that generates rebellion faster than being forced to play by the rules of a society that is not your own, and that taxonomists often operate as marginally as possible to society ("you let me collect my butterflies and I will have no opinion about your dictatorship").

6) Be a sincere, detailed and appreciative user of a taxonomist's output. Every identification is output, every teaching of how to tell this bug from that bug is output, every minute put into helping a curator put together a field guide is output. And it is all technology transfer and should be rewarded as such.

7) Recognize that taxonomists are not "big budget scientists". They are accustomed to barter. And one of the most valuable kinds of barter is specimens and natural history of their focal taxon. This is not because they are going to sell them, but because they need them to develop the mystery story solutions so dear to their hearts, the puzzles that attracted many of them to taxonomy in the first place. This means that the INBio that can come up with rules of the game allowing the taxonomist to keep on doing taxonomy yet not be a source of economically disastrous biodiversity leaks is going to be very high on the taxonomist's list of favorites.

8) Go to the taxonomists. Taxonomists are people. They like having friends and want their work to be appreciated. But there are not very many people in the world interested in skipper butterflies. They cannot leave their jobs easily. Money invested in the INBio curators to be able to visit the international taxonomists for periods of intensive work will pay handsome dividends in technology transfer.

9) Bring the international taxonomists to INBio. This is partly accomplished by 1) above. However, if this system is functioning correctly, INBios should eventually have the resources to be able to finance bringing the taxonomists to the specimens. In INBio he sees just what the parataxonomists and curators are really capable of doing, he sees a huge mass of new material in his taxa, he sees people who really want what he can produce, and to the degree he can get the time, he can enjoy his organisms in the field. And there is relative freedom from all the daily hassles back home.

10) Offer bright and enthusiastic collaborators as curators and parataxonomists, and the remainder of the INBio staff.

Regional and national versus monographic work.

For very many taxonomists, the dream is to really clean up some major group of organisms - not only have their species-level taxonomy clean and unambiguous, but also to have the species correctly assigned to higher taxa and understand the most likely evolutionary and biogeographic relationships of all of these taxa. Since most major taxa range across many countries and major habitat types, the taxonomist is uninclined to focus all his or her attention on a single region or country. A consequence is that it will be many centuries before such a very broad focus will bring tropical taxonomy up to a level whereby it forms a truly solid base for the general use of all tropical biodiversity by society. And after those centuries, there won't be much wildland tropical biodiversity to apply it to.

There are, however, a variety of advantages to working with national or regional floras and faunas, especially if the "legwork" is primarily carried out by the parataxonomists and curators. Very large series of specimens of both sexes and of various ages from many different habitats offer major opportunities to sort out ecophenotypes and other kinds of variation.

Thorough collecting in one area often results in the discovery of sympatries that resolve questions of sibling species. As the number of collections increase, natural history information accumulates. Equally, as the organisms become better known locally, even when rare, there is an ever-increasing chance that the parataxonmists and curators can respond by additional collecting of a given taxon as indicated by the taxonmist. Finally, the work done for a local flora and fauna is certainly not wasted when it comes time to produce a definitive monograph for a taxon.

More administratively, local floras and faunas lead to finished intermediate products (electronic and hard copy field guides, reference collections) which both show actual results (as opposed to an annual progress report for a 20-year monograph) to funding sources and generate yet greater interest by the user community. This greater interest may result in both more natural history information being collected and a greater local political will to support the entire INBio process.